Adjustable Precision Shunt Regulator

FEATURES

- Low voltage operation (2.5V)
- Adjustable output voltage from $V_O = V_{REF}$ to 18V
- Wide operating current range from 0.4mA to 100mA
- Low dynamic output impedance 0.5Ω max.
- ESD rating is 5.5kV (per MIL-STD 883D)
- **Pb-free lead finish available.**

APPLICATIONS

- Linear Regulators
- Adjustable Supplies
- Switching Power Supplies
- Battery Operated Computers
- Instrumentation
- Computer Disk Drives

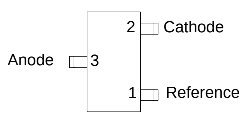
DESCRIPTION

The SS431 is a low-voltage three-terminal adjustable shunt regulator with a guaranteed thermal stability over the applicable temperature range. The output voltage can be set to any value between V_{REF} (approximately 2.5V) to 18V with two external resistors (see application circuit). This device has a typical output impedance of 0.2 ohms. Active output circuitry provides very sharp turn-on characteristics, making this device an excellent replacement for Zener diodes in many applications.

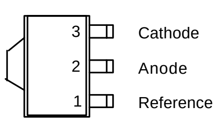
The SS431 is characterized for operation from 0°C to 105°C, and three package options (SOT-23, SOT-89, and TO-92) allow the designer the opportunity to select the proper package for his application. **The SS431 is available with a Pb-free lead finish - order as SS431Gxx.**

PIN CONFIGURATION

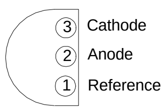
SOT-23 (Top view)



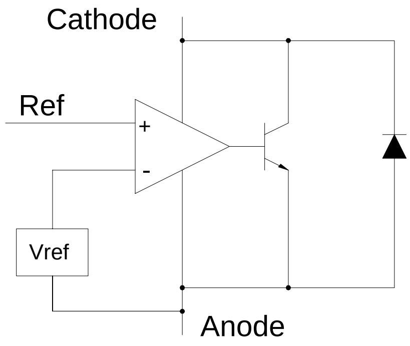
SOT-89 (Top view)



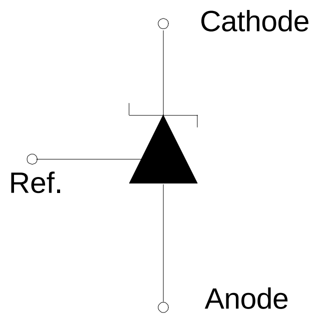
TO-92 (Top view)



BLOCK DIAGRAM



SYMBOL



ABSOLUTE MAXIMUM RATINGS over ambient temp. range.

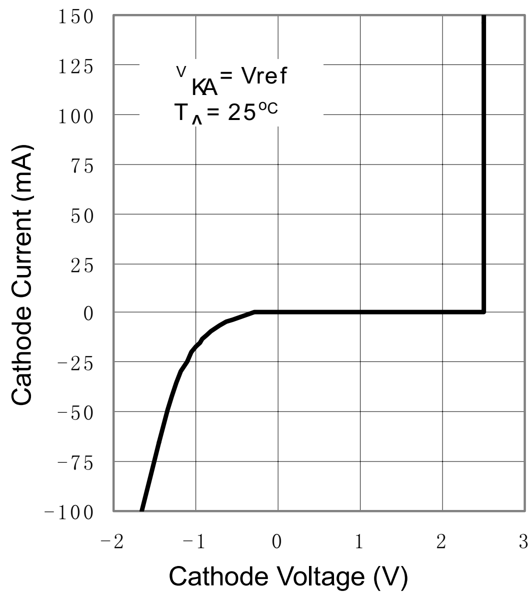
Parameter	Symbol	Maximum	Units
Cathode Voltage	V_{KA}	18	V
Continuous Cathode Current	I_{KA}	150	mA
Reference Current	I_{REF}	10	mA
Operating Junction Temperature	T_J	125	℃
Storage Temperature Range	T_{STG}	-65 to 150	℃
Thermal Resistance	θ_{JA}	156	℃/W
Lead Temperature (Soldering) 10 seconds	T_{LEAD}	260	℃

ELECTRICAL CHARACTERISTICS $T_A = 25$℃

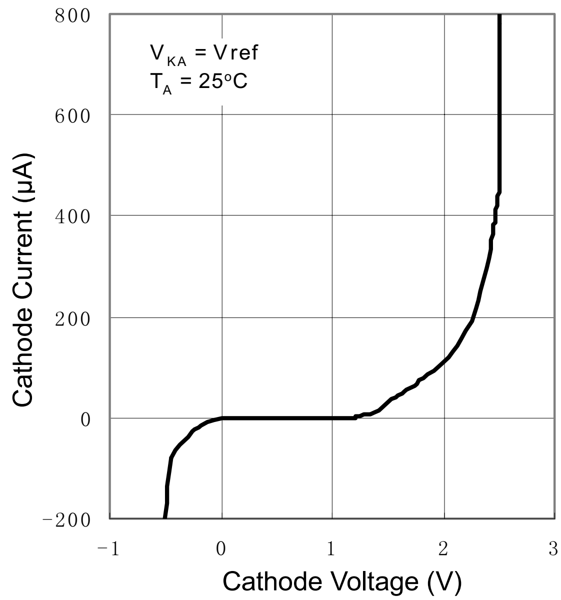
PARAMETER			TEST CIRCUIT	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reference voltage	1%	V_{ref}	1	$V_{KA} = V_{ref}$ $I_{KA} = 10mA$	2470	2495	2520	mV
Deviation of reference voltage Over full temperature range		$V_{I(dev)}$	1	$V_{KA} = V_{ref}$, $I_{KA} = 10mA$ T_A = full range		4	25	mV
Ratio of change in reference voltage to the change in cathode voltage		$\frac{\Delta V_{ref}}{\Delta V_{KA}}$	2	$I_{KA} = 10mA$ $\Delta V_{KA} = 10\ V - V_{ref}$		-1.4	-2.7	mV/V
Reference current		I_{ref}	2	$I_{KA} = 10mA$, R1=10kΩ, R2 = ∞		2	4	µA
Deviation of Reference current over full temperature range		$I_{I(dev)}$	2	$I_{KA} = 10mA$, R1=10kΩ, R2 = ∞ T_A = full range		0.4	1.2	µA
Minimum cathode current for regulation		I_{min}	1	$V_{KA} = V_{ref}$		0.4	1	mA
Off-state cathode current		I_{off}	3	$V_{KA} = 18V$, $V_{ref} = 0$		0.1	1	µA
Dynamic impedance		r_Z	1	$I_{KA} = 1mA$ to 100mA, $V_{KA} = V_{ref}$ $f \le 1kH_Z$		0.2	0.5	Ω

TYPICAL PERFORMANCE CHARACTERISTICS

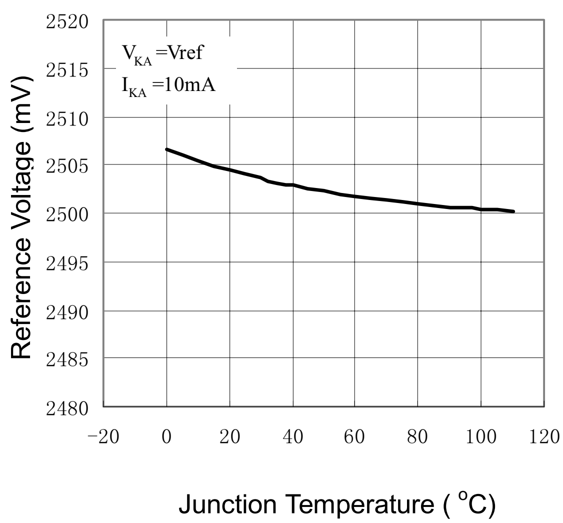
CATHODE CURRENT
Vs.
CATHODE VOLTAGE



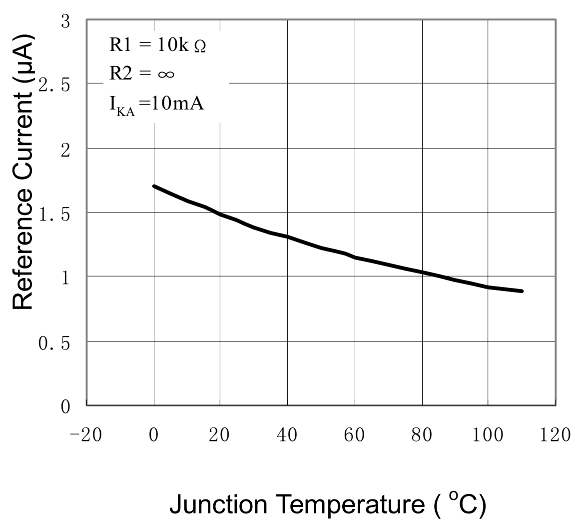
CATHODE CURRENT
Vs.
CATHODE VOLTAGE



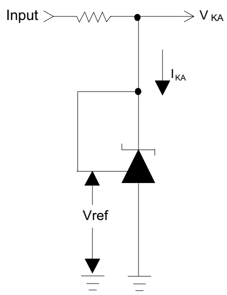
REFERENCE VOLTAGE
Vs.
JUNCTION TEMPERATURE

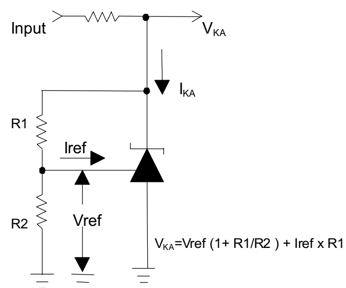


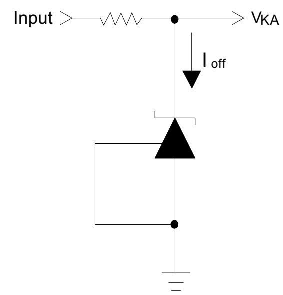
REFERENCE INPUT CURRENT
Vs.
JUNCTION TEMPERATURE



TEST CIRCUITS





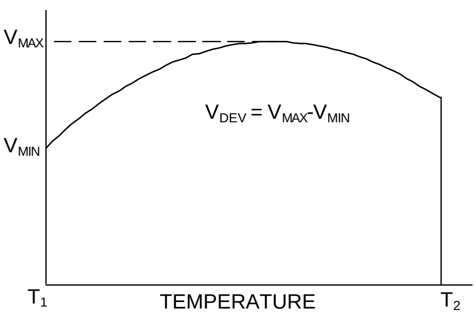


Test Circuit 1:
V_{KA} = Vref

Test Circuit 2:
V_{KA} > Vref

Test Circuit 3:
Off State Current

APPLICATION INFORMATION



Deviation of reference input voltage, V_{DEV}, is defined as the maximum variation of the reference input voltage over the full temperature range.

The average temperature coefficient of the reference input voltage, αV_{REF} is defined as:

$$\Delta V_{REF}\frac{ppm}{^\circ C} = \frac{\pm\left[\frac{V_{MAX} - V_{MIN}}{V_{REF}(at\ 25^\circ C)}\right]10^6}{T2 - T1} = \frac{\pm\left[\frac{V_{DEV}}{V_{REF}(at\ 25^\circ C)}\right]10^6}{T2 - T1}$$

Where:
T_2–T_1=full temperature change.
αV_{REF} can be positive or negative depending on whether the slope is positive or negative.
Example: V_{DEV}= 7.0mV, V_{REF}= 2495mV, T_2–T_1= 105°C, slope is negative.

$$aV_{REF} = \frac{\left[\frac{7.0mV}{2495mV}\right]10^6}{105^\circ C} = -27ppm/^\circ C$$

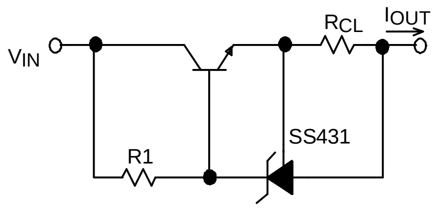
Note 4. The dynamic output impedance, R_Z, is defined as:

$$R_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

When the device is programmed with two external resistors, R1 and R2, (see Fig. 2), the dynamic output impedance of the overall circuit, is defined as:

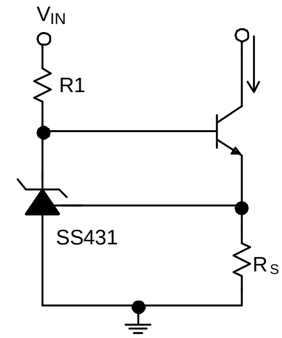
$$r_Z = \frac{\Delta V}{\Delta I} \cong R_Z\left[1 + \frac{R1}{R2}\right]$$

APPLICATION EXAMPLES



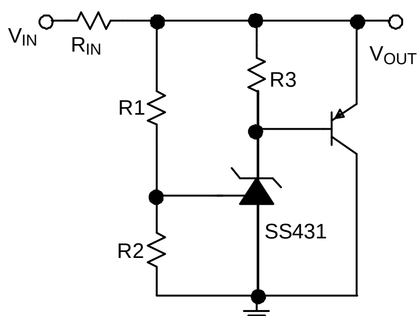
$I_{OUT}=V_{REF}/R_{CL}$

Current Limiter or Current Source



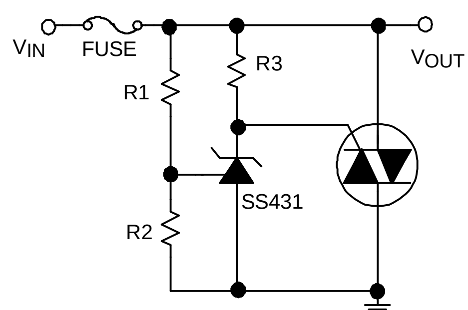
$I_{OUT}=V_{REF}/R_S$

Constant-Current Sink



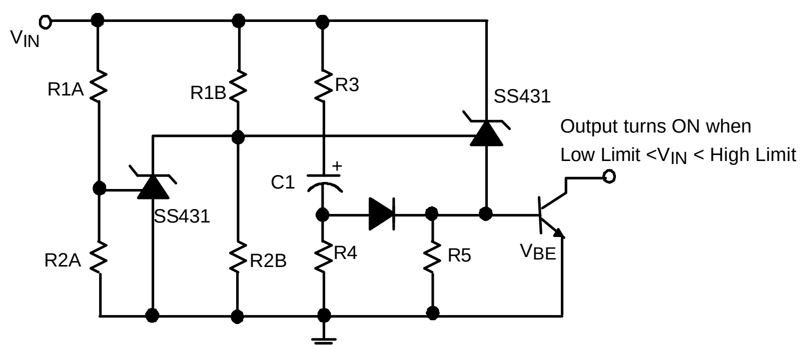
$V_{OUT} \cong (1+R1/R2) \times V_{REF}$

Higher-Current Shunt Regulator



$V_{LIMIT} \cong (1+R1/R2) \times V_{REF}$

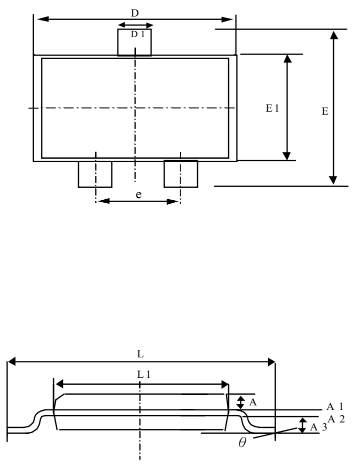
Crow Bar



Low Limit $\cong V_{REF}$ (1+ R1B/ R2B)+ V_{BE}
High Limit $\cong V_{REF}$ (1+ R1A/ R2A)

Over-Voltage/Under-Voltage Protection Circuit

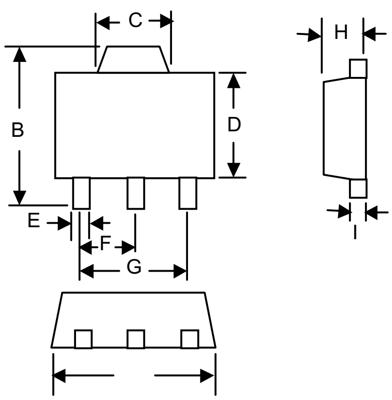
PHYSICAL DIMENSIONS SOT-23



SYMBOL	MIN	NOM	MAX
A	0.20	0.30	0.40
A1	–	0.00	–
A2	–	0.10	–
A3	0.70	0.80	0.90
D1	0.30	0.40	0.50
e	1.70	2.00	2.30
D	2.80	2.90	3.00
E	2.25	2.50	2.75
E1	1.40	1.50	1.60
L	2.25	2.50	2.75
L1	1.40	1.50	1.60
θ	–	2°	–

Unit: :mm

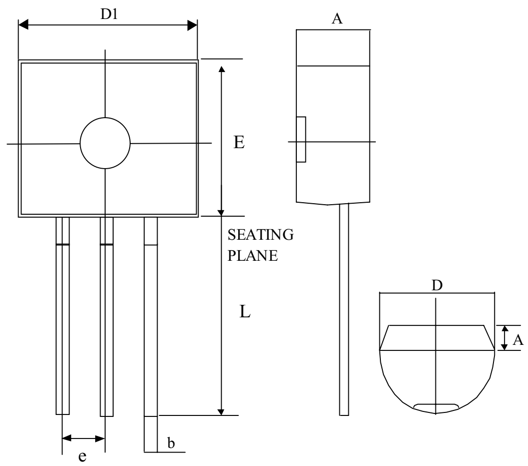
SOT-89



SYMBOL	MIN	MAX
A	4.40	4.60
B	4.05	4.25
C	1.50	1.70
D	2.40	2.60
E	0.31	0.46
F	1.48	1.52
G	2.96	3.04
H	1.40	1.60
I	0.35	0.41

Unit: :mm

PHYSICAL DIMENSIONS TO-92



SYMBOL	MIN	NOM	MAX
A	3.45	3.56	3.66
A1	1.22	1.3	1.37
b	-	0.38	-
D1	4.27	4.52	4.78
D	4.14	4.29	4.45
E	4.32	4.57	4.83
e	-	1.27	-
L	12.98	13.49	14.00

Unit: mm

ORDERING INFORMATION

SS431(G)xBxx

TR: Tape and Reel Packing

Bandgap tolerance
B = 1%

Package type
N = SOT-23-3
T = TO-92
G = SOT-89

Lead finish option: G for Pb-free lead finish

Example: SS431GNBTR

SS431 with 1% tolerance in SOT-23-3 with pb-free lead finish shipped on tape and reel